Balanced Nutrition & Crop Production Practices for Sorghum Nutrient Partitioning & Closing Yield Gaps

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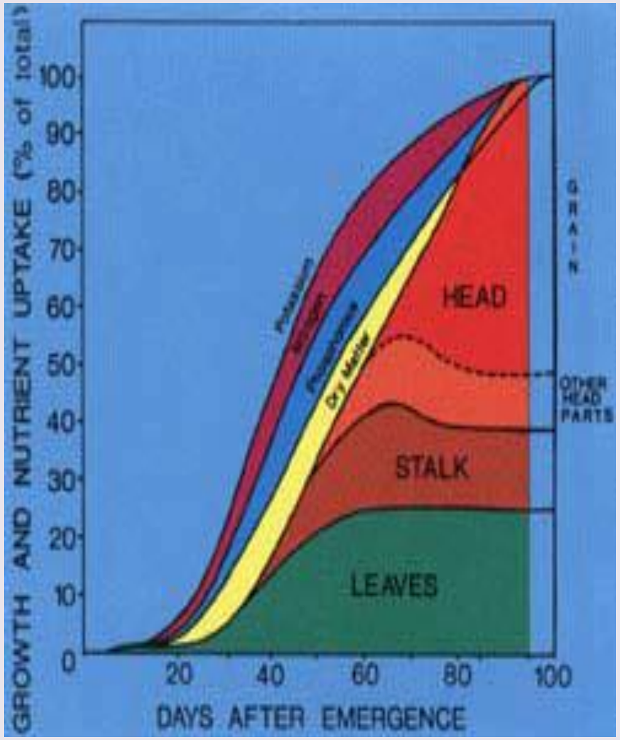
Introduction

- In sorghum production, complex effects of genotype (G), environment (E), and management (M)
- A better understanding of G x E x M interactions will optimize of the use of all soil, plant, and water resources.
- Opportunities exist to close the yield gaps between maximum economic attainable yield and current on-farm yields.
- In need of information on nutrient uptake in modern sorghum hybrids.



Vanderlip, 1973

Objectives

- Understand the effect of fertilizer applications and their interactions with diverse management practices
- Identify management factors that contribute to high sorghum yields
- Investigate nutrient uptake and partitioning under different environments and crop production practices

Materials & Methods

- **11 Treatments, 5 reps/location:**

1) (KS) Full Treatment or "Kitchen Sink" (high plant pop., 15" rows, GreenSeeker N, Insecticide/fungicide, micronutrients, starter fertilizer, plant growth regulator)
2) (PD) Plant Density (40,000 vs. 80,000)
3) (RS) Row Spacing (30" rows)
4) (Pre-N) Nitrogen (50 lbs/acre all at pre-planting)
5) (FI) Foliar Fungicide/Insecticide (Without chemicals)
6) (Micro) Foliar Micronutrients (Fe, Zn) (Without micronutrients)
7) (PGR) Plant Growth Regulator (Without PGR)
8) (NP) Fertilizer NPKS Starter (only NP starter)
9) (Cl) Chloride (Without Chloride)
10) (FP) Farmer Practice (Lower plant pop., wide rows, NP starter)
11) (KS+N) Non-limiting N = Kitchen Sink +N (Treatment #1 + 50 lbs extra N)

Treatments & Experimental Design

	Treatments										
	1 (KS)	2 (PD)	3 (RS)	4 (PD)	5 (F/I)	6 (Micros)	7 (PGR)	8 (NP)	9 (Cl)	10 (FP)	11 (KS+N)
Seeding rate	Optimum	Normal	Optimum	Optimum	Optimum	Optimum	Optimum	Optimum	Optimum	Normal	Optimum
Row Spacing	15"	15"	30"	15"	15"	15"	15"	15"	15"	30"	15"
N Program	GS	GS	GS	Standard	GS	GS	GS	GS	GS	Standard	GS
Fungicide/Insecticide	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Micronutrients	Fe, Zn	Fe, Zn	Fe, Zn	Fe, Zn	Fe, Zn	None	Fe, Zn	Fe, Zn	Fe, Zn	None	Fe, Zn
PGR	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Starter Fertilizer	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NPKSZn	NP	NPKSZn	NP	NPKSZn
Chloride	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
GreenSeeker +N	No	No	No	No	No	No	No	No	No	No	Yes

Soil Characterization

Location	Sample Depth	pH	Mehlich P	K	Summation CEC	OM	NH_4-N	NO_3-N
	cm		ppm	ppm	meq/100g	%	ppm	ppm
Topeka	15	6.9	67.1	395	17.9	2.86	-	-
Ottawa	15	6.3	**12.1**	128.1	20.5	3.15	-	-
Scandia	15	6.4	**11.9**	476.6	19.9	3.16	-	-
Ashland	15	7.9	59.8	264.3	12.1	1.58	-	-

Data Collection

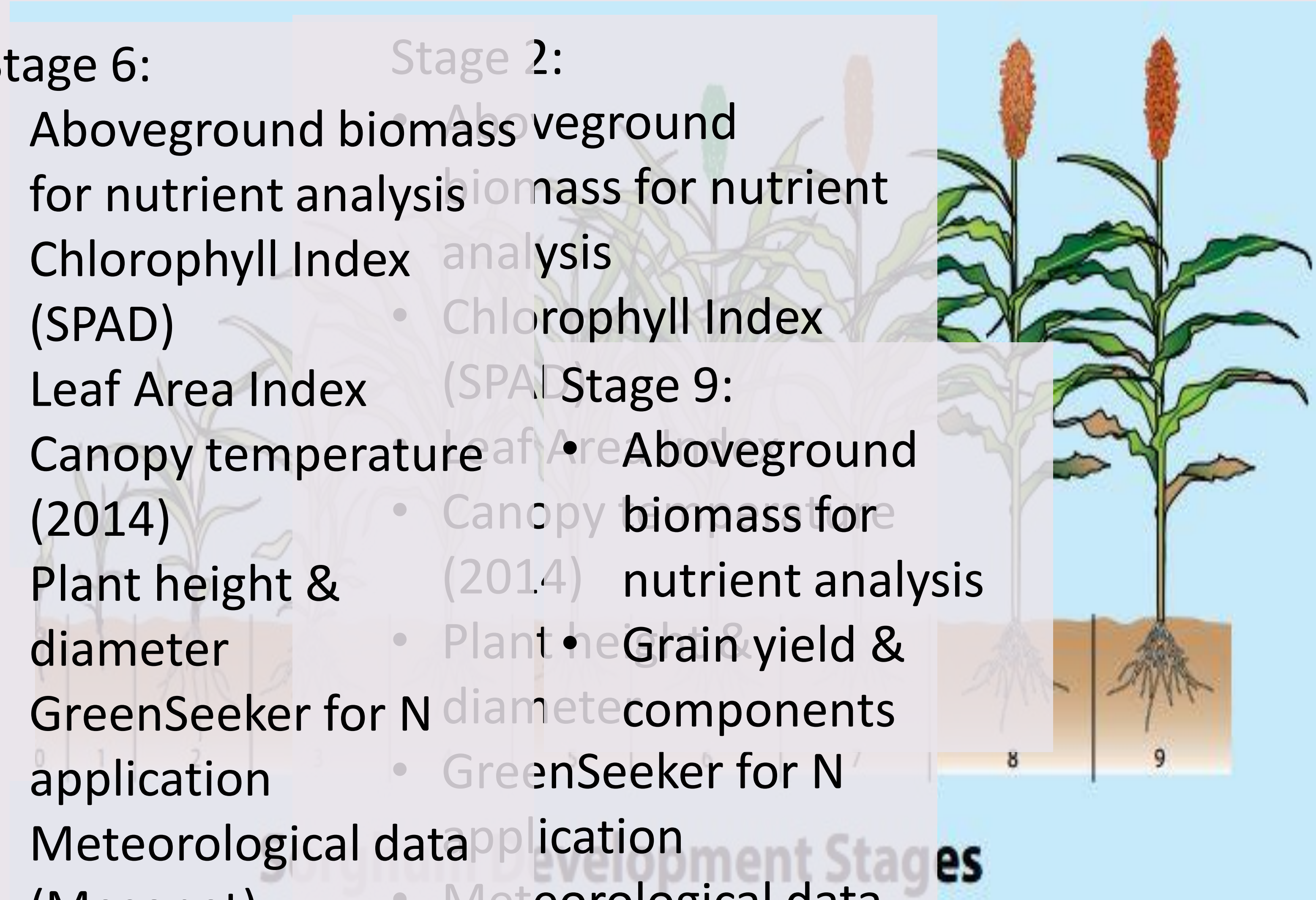
- Pre-plant soil tests

Stage 1:
- Stand counts

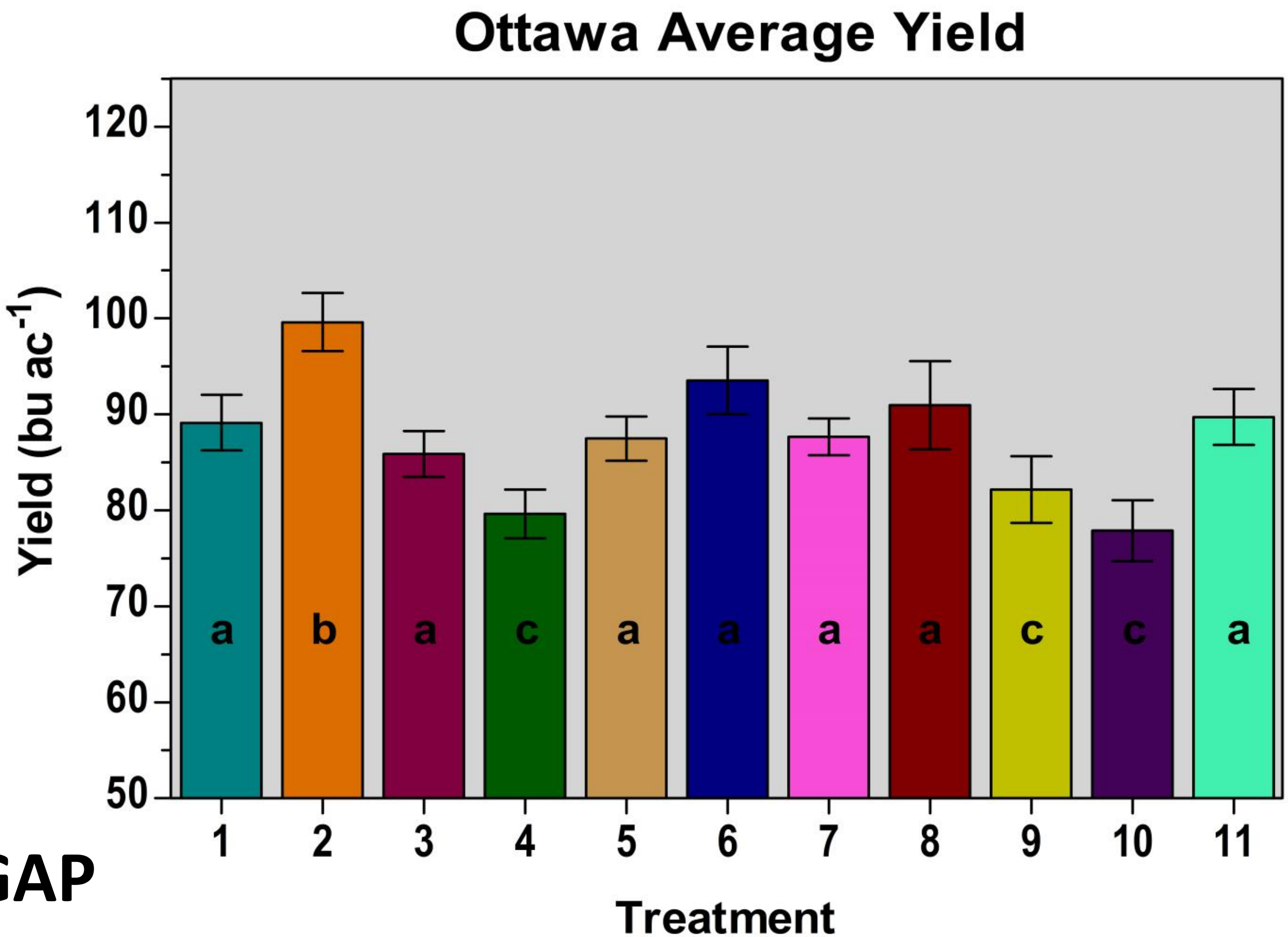
Stage 2:
- Aboveground biomass for nutrient analysis
- Chlorophyll Index (SPAD)
- Leaf Area Index
- Canopy temperature (2014)
- Plant height & diameter
- GreenSeeker for N application
- Meteorological data (Mesonet)

Stage 6:
- Aboveground biomass for nutrient analysis
- Chlorophyll Index (SPAD)
- Leaf Area Index
- Canopy temperature (2014)
- Plant height & diameter
- GreenSeeker for N application
- Meteorological data (Mesonet)

Stage 9:
- Aboveground biomass for nutrient analysis
- Grain yield & components



Closing Grain Sorghum Yield Gaps

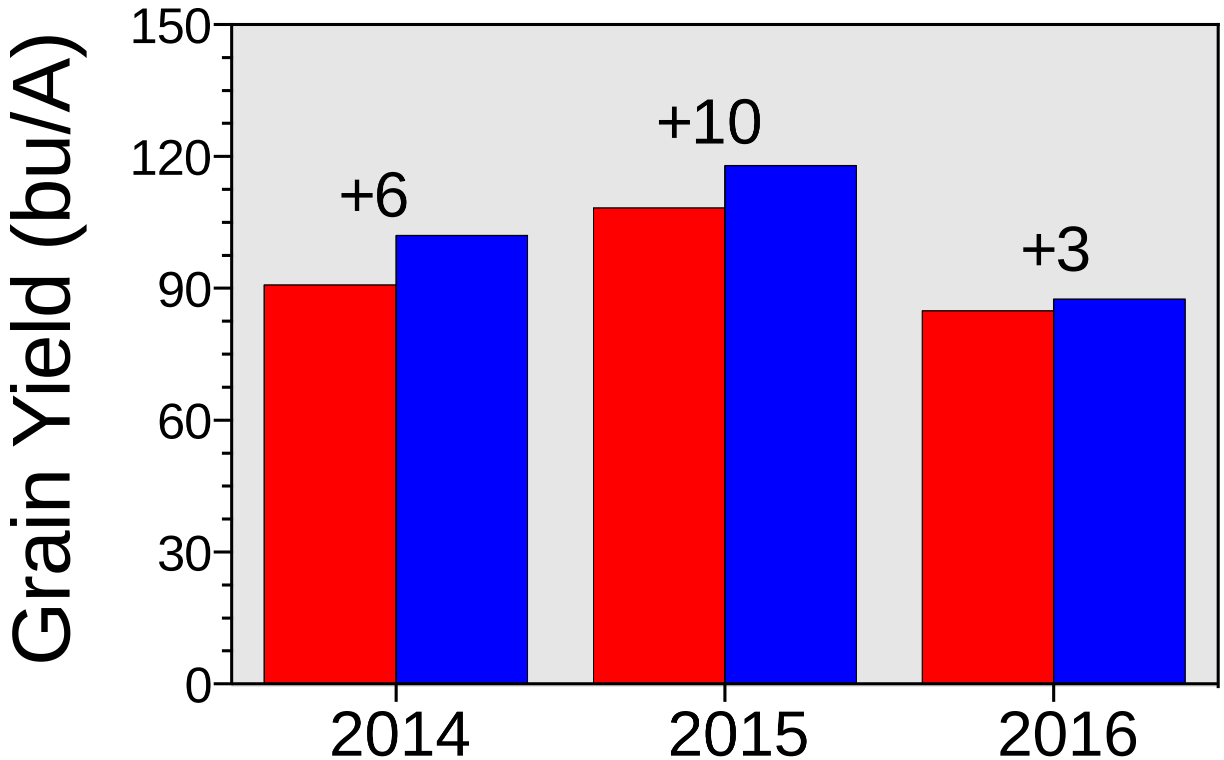


YIELD GAP
22 bushels per acre

MAX. YIELD #2
MIN. YIELD #4, 10

#2 = Kitchen Sink (-PD)
#10 = Common Practices

Closing Grain Sorghum Yield Gaps



Total 10 site-years

Yield Gap =
Kitchen Sink (-PD) vs. Common Practices

#2 = Kitchen Sink (-PD)
#10 = Common Practices

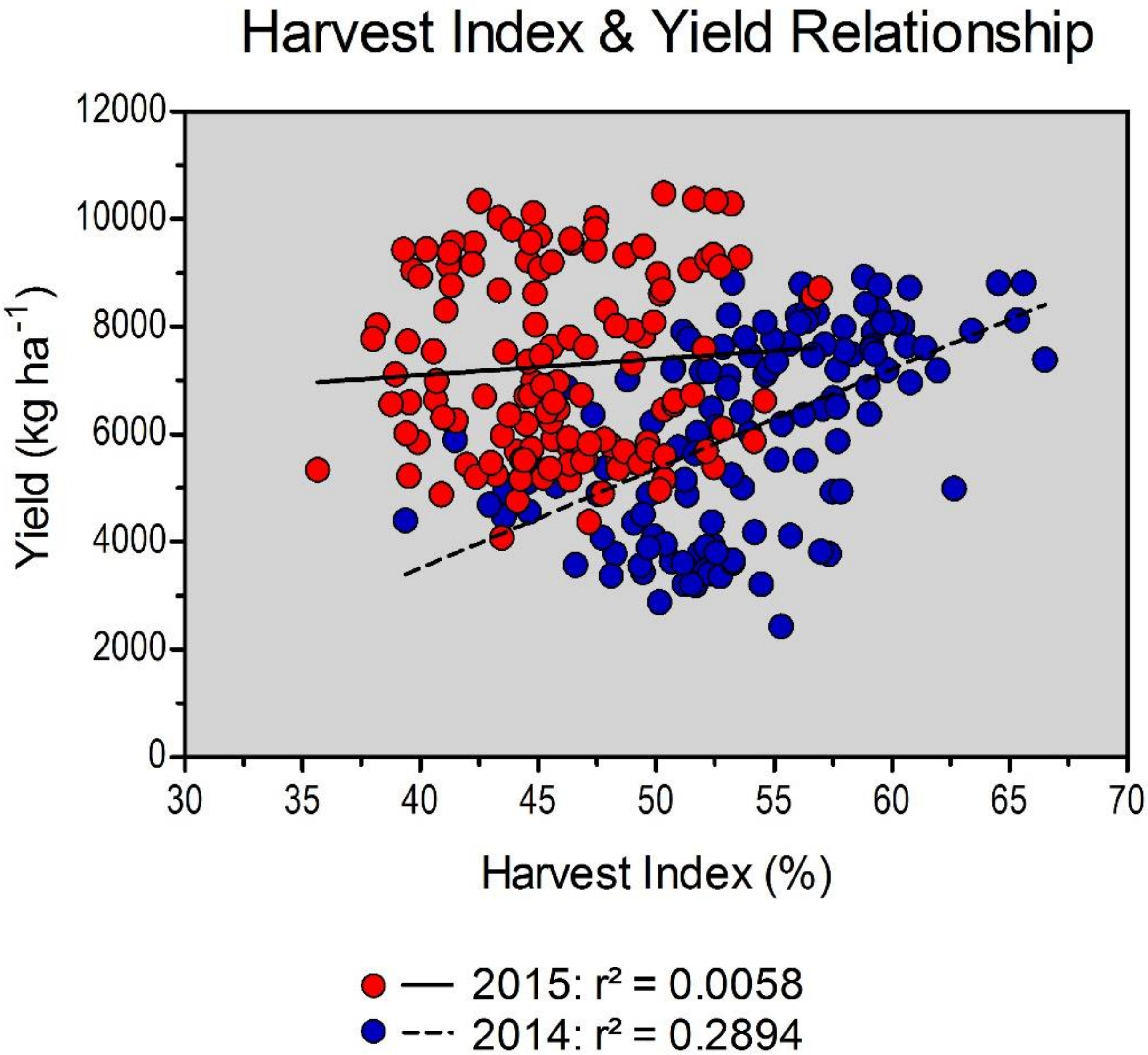
YIELD GAP INCREASES with YIELD POTENTIAL (Yp)

Yp 90 bu/acre = 3 bu/acre GAP

Yp 100 bu/acre = 6 bu/acre GAP

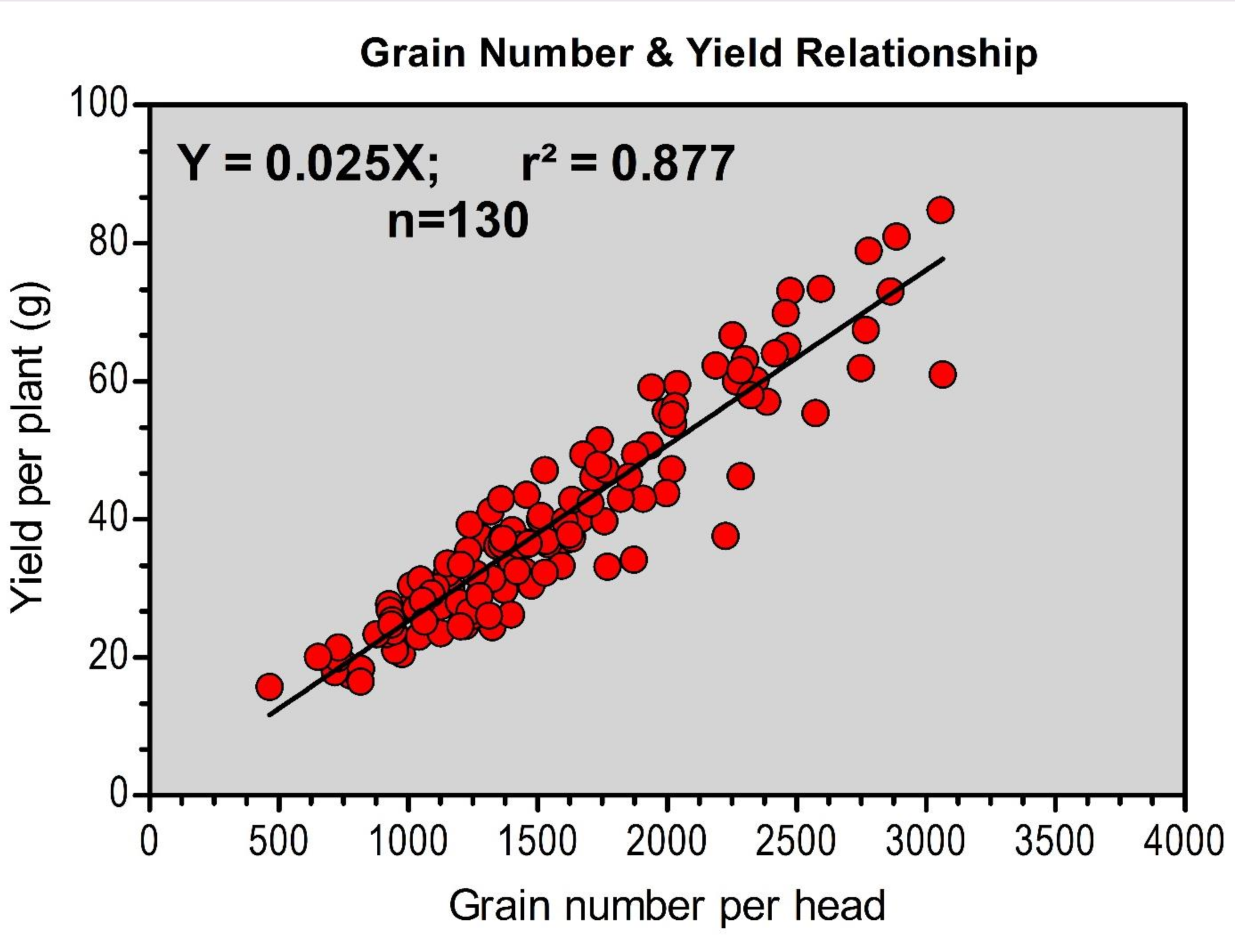
Yp 110 bu/acre = 10 bu/acre GAP

YIELD COMPONENTS: Grain Number Trait



Yield per plant was related to the final grain harvest index (HI), regardless of the treatments evaluated.

Grain Number vs. Yield 2014-15-16 (10-site-years)



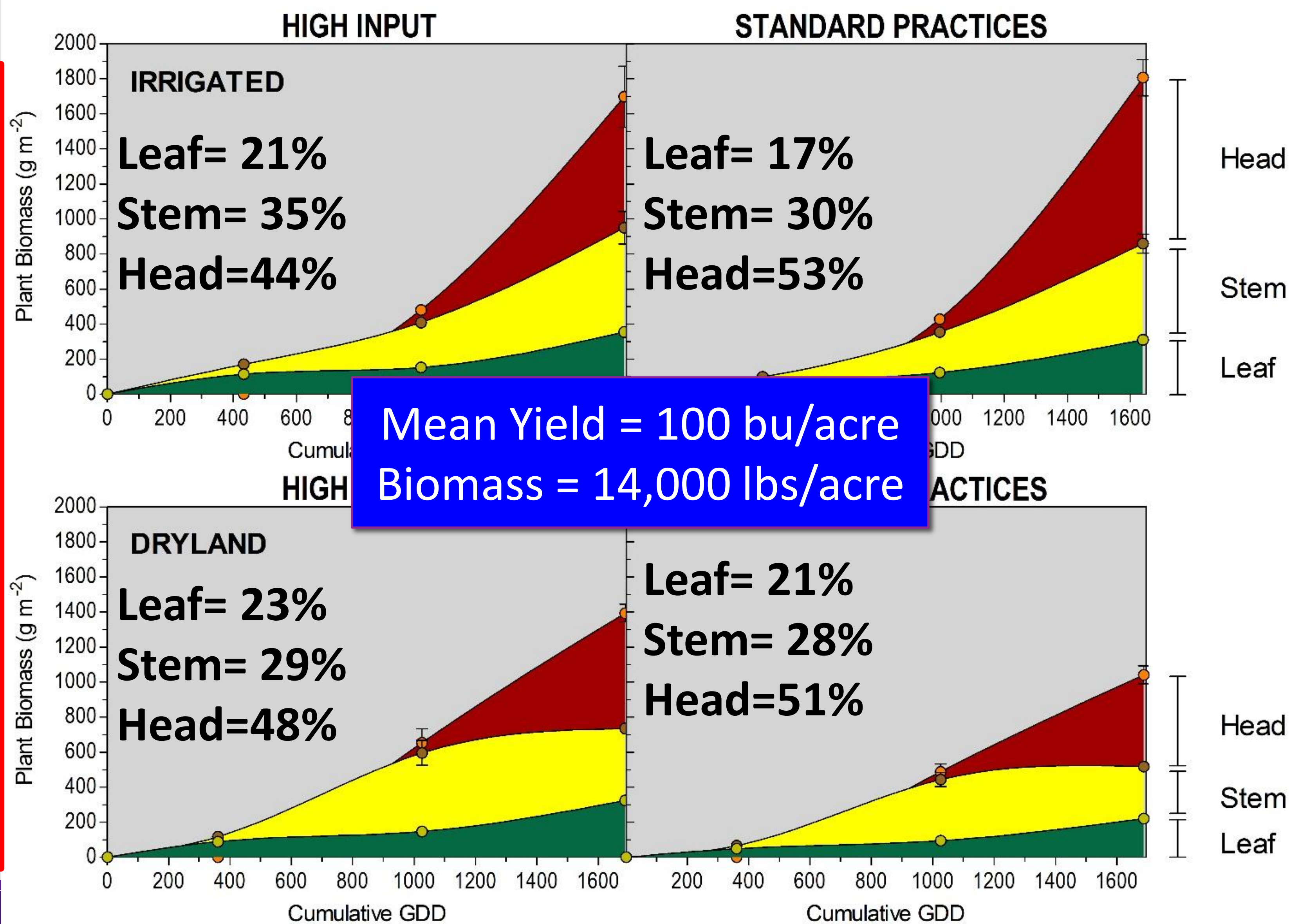
Yield per plant was highly related to the final grain number per head, regardless of the treatments evaluated.

Biomass Evolution

More BIOMASS accumulated after flowering = +yields

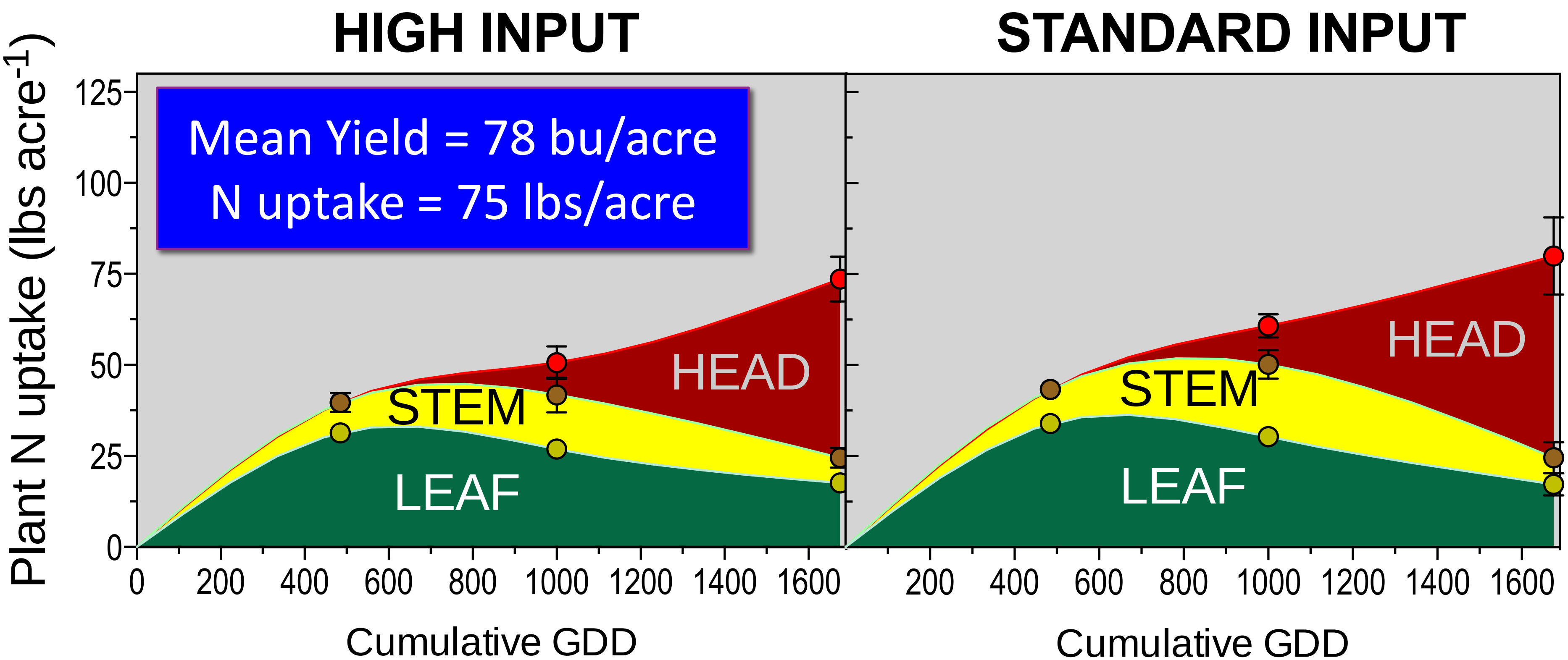
Irrigated
16,000 lbs/a
YIELD 110 bu/a

Dryland
11,000 lbs/a
YIELD 90 bu/a



Closing Grain Sorghum Yield Gaps

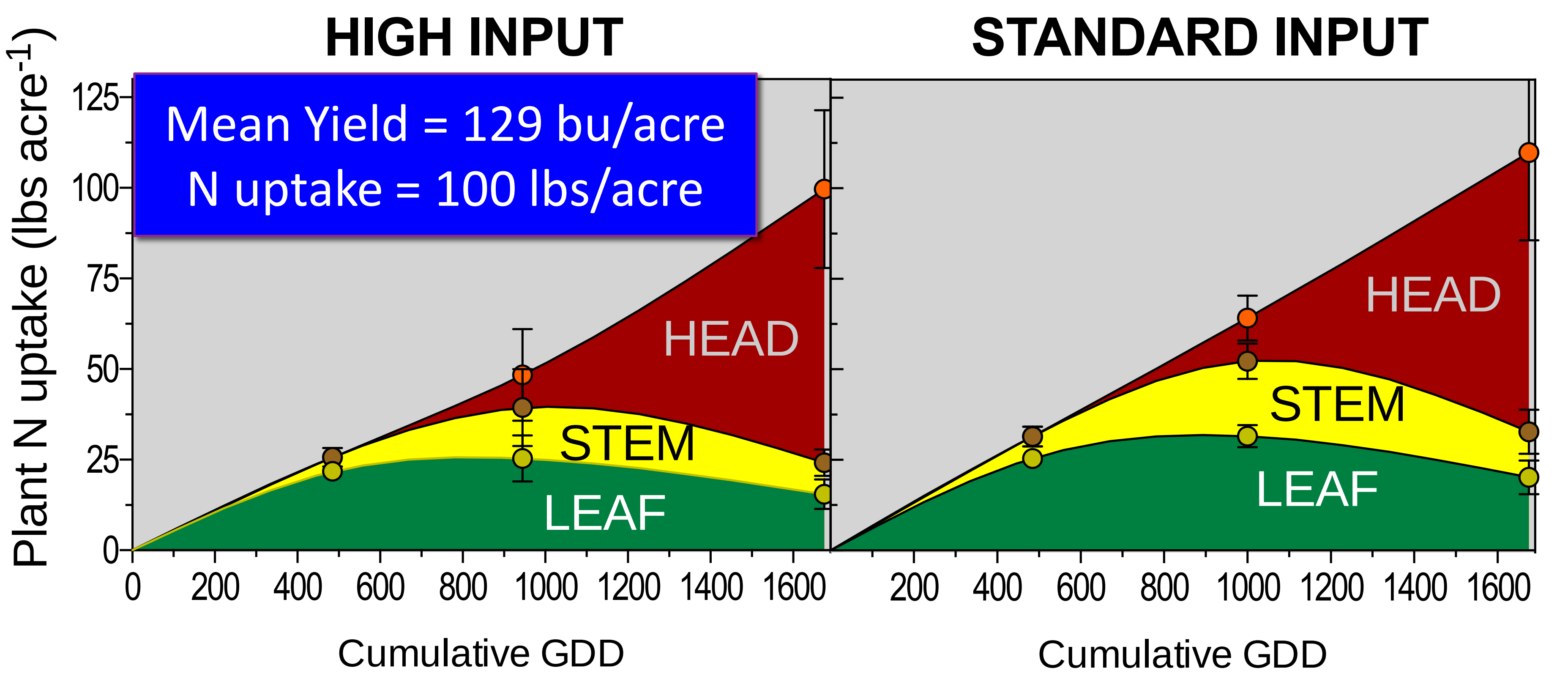
OTTAWA



Plant N uptake followed the biomass evolution with greater plant partition among all VEGETATIVE & REPRODUCTIVE fractions.

Closing Grain Sorghum Yield Gaps

ROSSVILLE



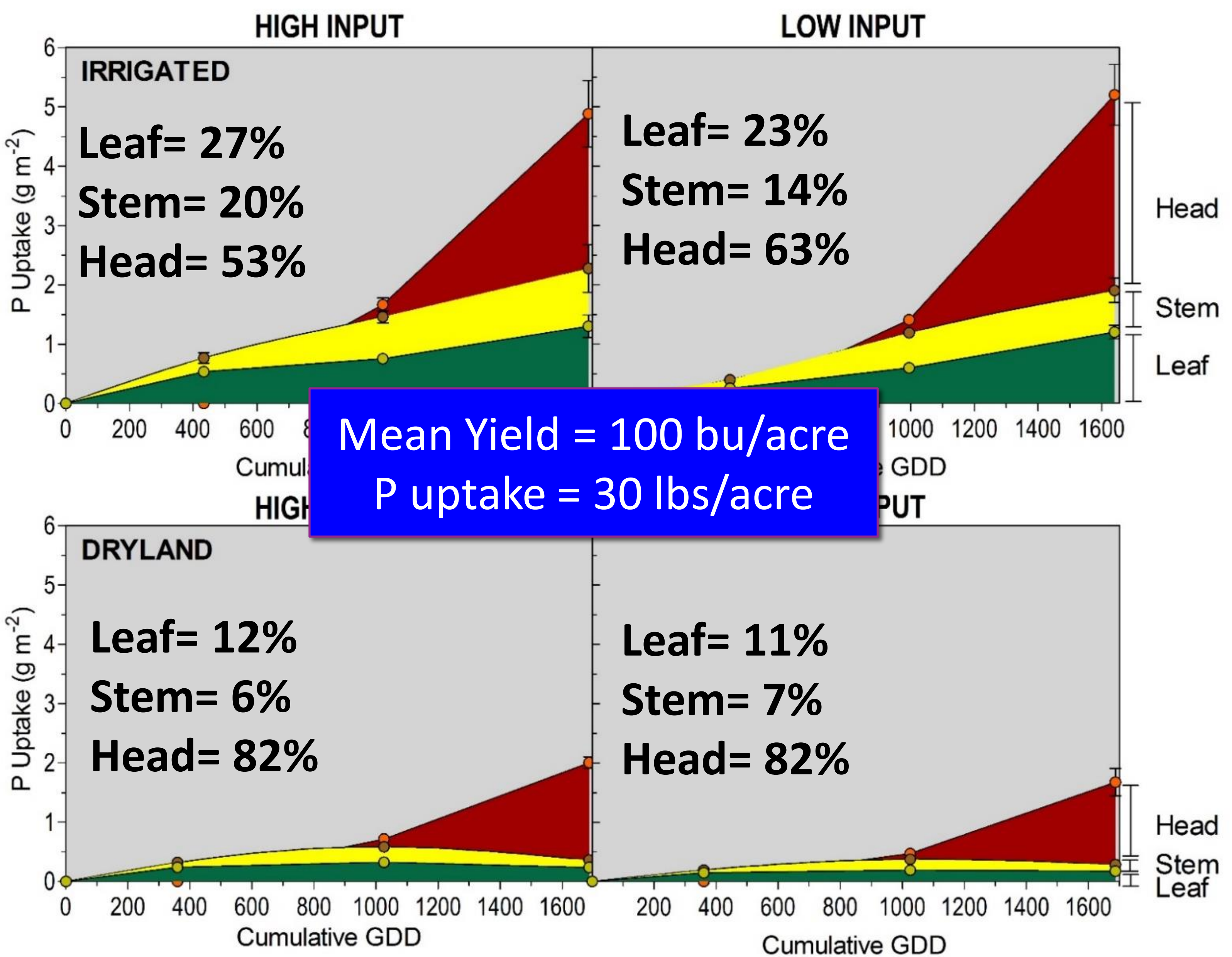
Plant N uptake followed the biomass evolution and also mean Yield levels in each environment.

Superior yield was translated into greater N uptake.

+P CONTENT = +yields

P uptake Evolution

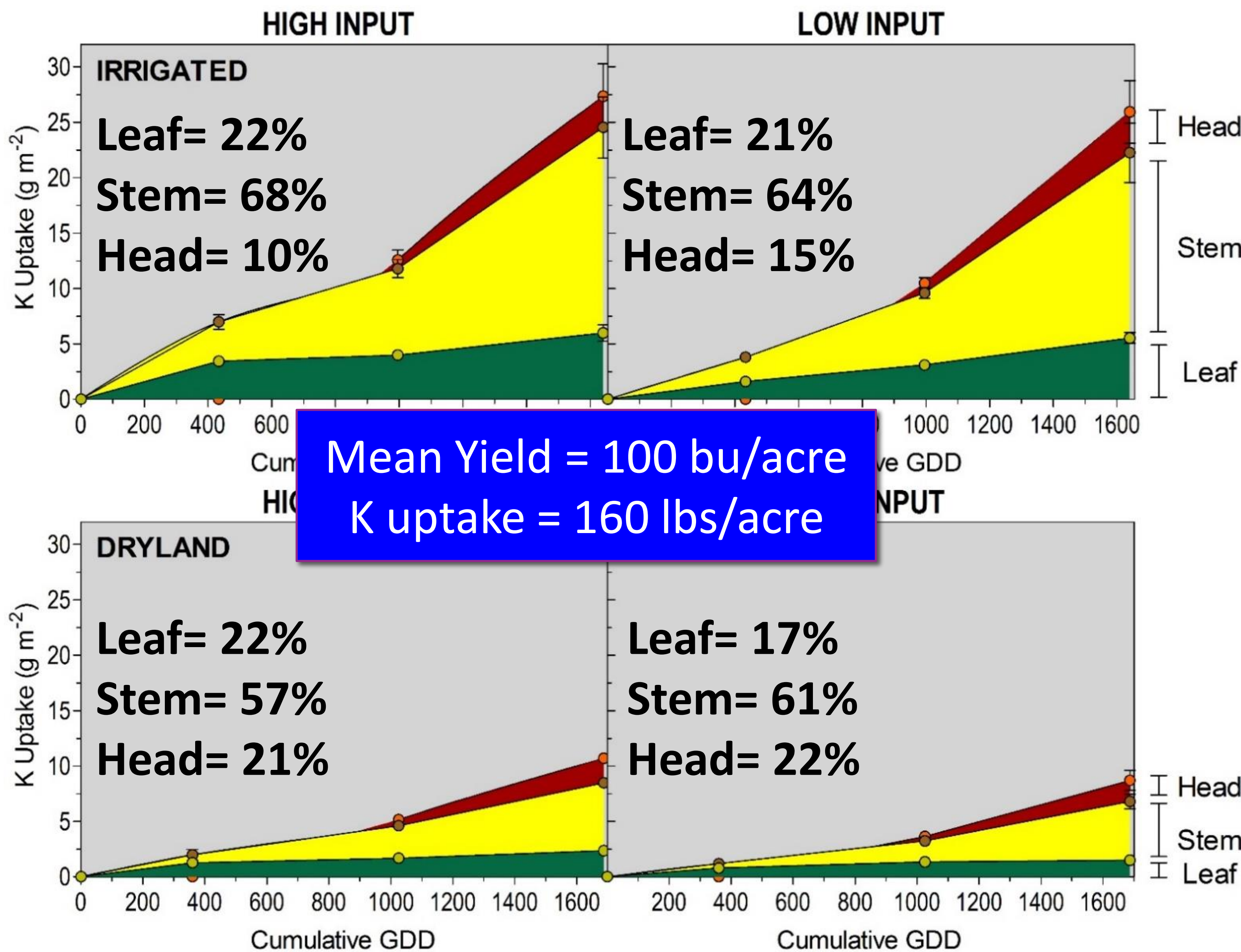
Irrigated
45 lbs/a
Dryland
18 lbs/a



K uptake Evolution

+K CONTENT = +yields

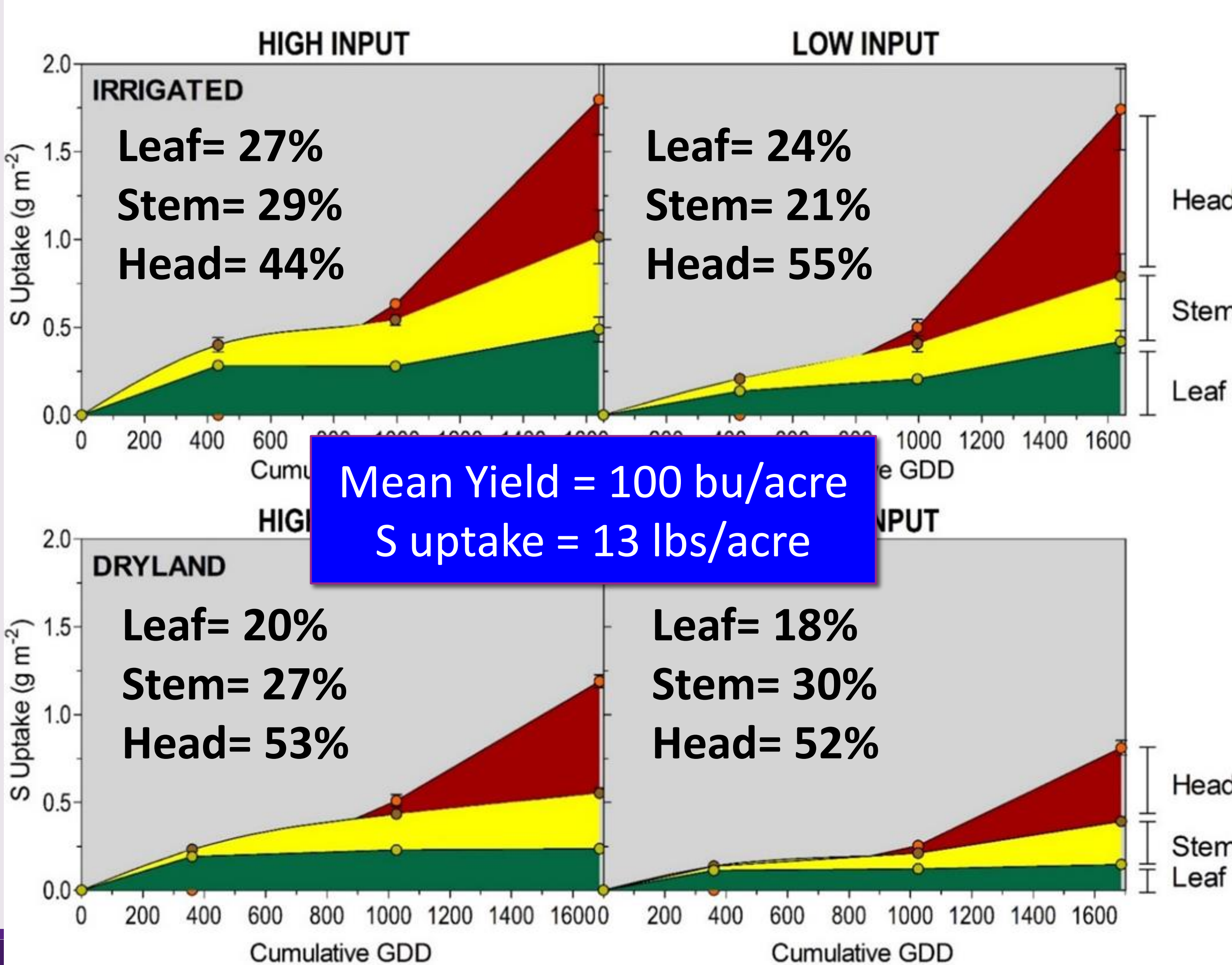
Irrigated
240 lbs/a
Dryland
90 lbs/a



S uptake Evolution

+S CONTENT = +yields

Irrigated 16 lbs/a
Dryland 10 lbs/a



Mean Yield = 100 bu/acre
S uptake = 13 lbs/acre

Summary

- Over both years and all sites, the standard practice (SP) treatment was generally out-yielded by the High Input (HI) approach, though it was not always statistically significant.

- During drought-stress conditions, the SP treatment yielded comparable as the HI approach.

- Under irrigation, yield variability was reduced, and more nutrients were accumulated in the grain portion at harvest time.

QUESTIONS?

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